THE HANFORD SITE

Soil and Groundwater

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Purpose

Objective of briefing:

- Provide overview of the Groundwater program to provide members understanding of current analysis regarding potential alternative pathways to achieve tank waste mission

What is being briefed?

- Requirements of the Groundwater program, what is being done to meet those requirements and what is being done in the near-term to support the program

What do we want the HAB to do with this information?

- Information is relevant in continued policy-level discussions regarding potential alternatives to safely increase efficiency in the Groundwater program

Introduction

- The Hanford Site, part of the DOE nuclear weapons complex, encompasses about 580 square miles along the Columbia River in southeastern Washington state. During World War II and the Cold War period, the government built and operated nine nuclear reactors for the production of plutonium and other nuclear materials.
- During reactor operations, chemical and radioactive wastes were released into the environment and contaminated the soil and groundwater beneath portions of the Hanford Site.
- Since 1989, using its authority under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), DOE has worked to respond to this contamination.

Introduction (cont.)

- The U.S. Environmental Protection Agency (EPA) placed the Hanford Site on the CERCLA National Priorities List in 1989, and DOE entered the *Hanford Federal Facility Agreement and Consent Order* (aka Tri-Party Agreement) with EPA and the Washington State Department of Ecology.
- The purpose of the Tri-Party Agreement is to provide a joint plan to address groundwater and vadose zone contamination, and other aspects of remediating the radiological and chemical contamination at the Hanford Site.

Goals

- Key goals of this effort are the following:
  - Protect the Columbia River and groundwater from further contamination
  - Develop a cleanup decision process
  - Restore groundwater to its highest beneficial use
- Actions taken by DOE to protect the Columbia River include the following:
  - Ceased discharge of unpermitted liquids
  - Remediated waste sites in the 100 and 300 Areas
  - Operate remedial actions, such as pump-and-treat facilities, to contain groundwater plumes and reduce the mass of contaminants

Sampling and Monitoring

- Over the lifetime of the Hanford Site, DOE has installed and maintained thousands of wells to monitor and remediate groundwater and provide geologic data.
- New monitoring well proposals are approved annually, in accordance with Tri-Party Agreement Milestone M-024.
- Monitoring plans and sampling and analysis plans define which wells to sample, how often to sample, and what constituents to analyze.
- DOE installs wells yearly to expand the sampling and monitoring capabilities, determine extent of contaminants of concern, and to support pump-and-treat operations.
- Groundwater monitoring results are documented in the annual Hanford Site Groundwater Monitoring Report.

Sampling and Analysis

- Twelve-year sampling stats (fiscal year 2009 to 2020)
  - Drilled and constructed 727 wells
  - Decommissioned 426 wells that were no longer needed at Hanford
  - Sampling group went on 33,494 routine well trips to obtain sample data, plus multiple samples were taken at each well
  - The Sample Management and Reporting group processed 455,112 sample analysis
- The predominant contaminants in Columbia River corridor groundwater include hexavalent chromium, nitrates, and strontium-90.
- The predominant contaminants in Central Plateau groundwater include carbon tetrachloride, trivalent and hexavalent chromium, cyanide, nitrates, trichloroethene, iodine-129, technetium-99, and uranium.

Sampling and Analysis (cont.)

- Remediation capabilities include the following:
  - Five pump-and-treat facilities along the Columbia River
  - One pump-and-treat facility on the Central Plateau (200 West Pump and Treat Facility)
  - A permeable reactive barrier for strontium-90 in the 100-N Area
  - Enhanced attenuation of uranium in the 300 Area, and monitored natural attenuation in the 100-F Area
- The 200 West Pump and Treat Facility also treats Environmental Restoration Disposal Facility (ERDF) leachate and Modu-Tank water (looking at possibly treating Integrated Disposal Facility (IDF) leachate and Mixed Waste Trench leachate – delisting required).

Sampling and Analysis

- 3,286 unique well locations are actively in use as of Jan. 20, 2020.
  - 301 at Central Plateau Outer Zone
  - 694 at Central Plateau Inner Zone
  - 52 at Hanford Reach National Monument
  - 1,385 at River Corridor
  - 854 at Tank Farms (Office of River Protection)
- Progress as of Sept. 30, 2020
  - Groundwater Treated (26 billion gallons)
  - Hexavalent Chromium Removed (4,169 kg)
  - Carbon Tetrachloride Removed (112,653 kg)
  - Nitrates Removed (494,227 kg)
  - Uranium Removed (976 kg)
  - Technetium-99 Removed (17 Curies)

Reporting

- The Hanford Site Groundwater Monitoring Report is available for public review at two different locations:

https://pdw.hanford.gov/document/AR-04040

The Administrative Record

  - Contains the calendar year groundwater monitoring results.

https://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports

Interactive Reporting Tool

  - Contains the monitoring results of sampling performed
  - Contains a tutorial on how to navigate the maps and tools available for use of plume tool, charting tool and cross-section tool

Well Drilling

Sonic drill rig

Cable drill rig

Well Drilling (cont.)

Air rotary drill rig

High-density Polyethylene Piping

Hundreds of miles of high-density polyethylene piping transports groundwater to the pump-and-treat facilities.

Pipe weld station

Double-wall pipe

Sampling Equipment

Well purging

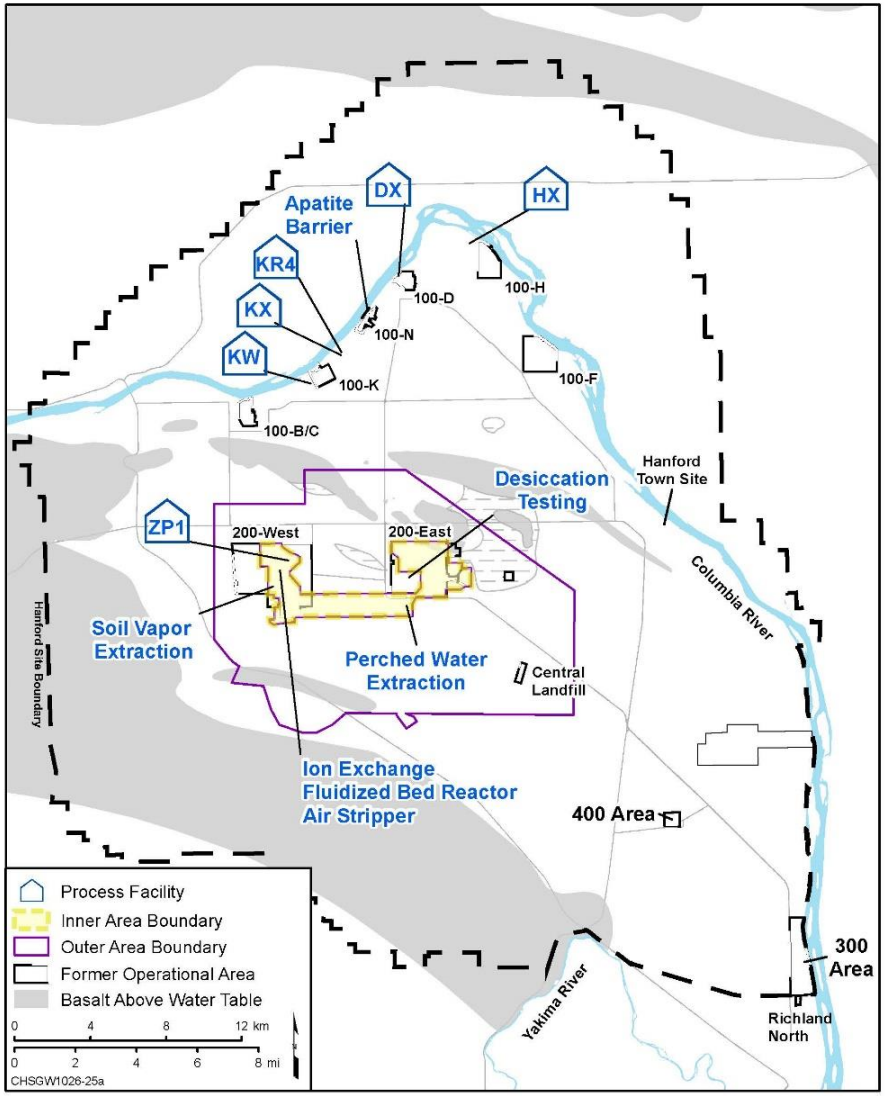
Sampling Equipment (cont.)

Well sampling

Soil Sampling

Well soil sample

Columbia River Corridor



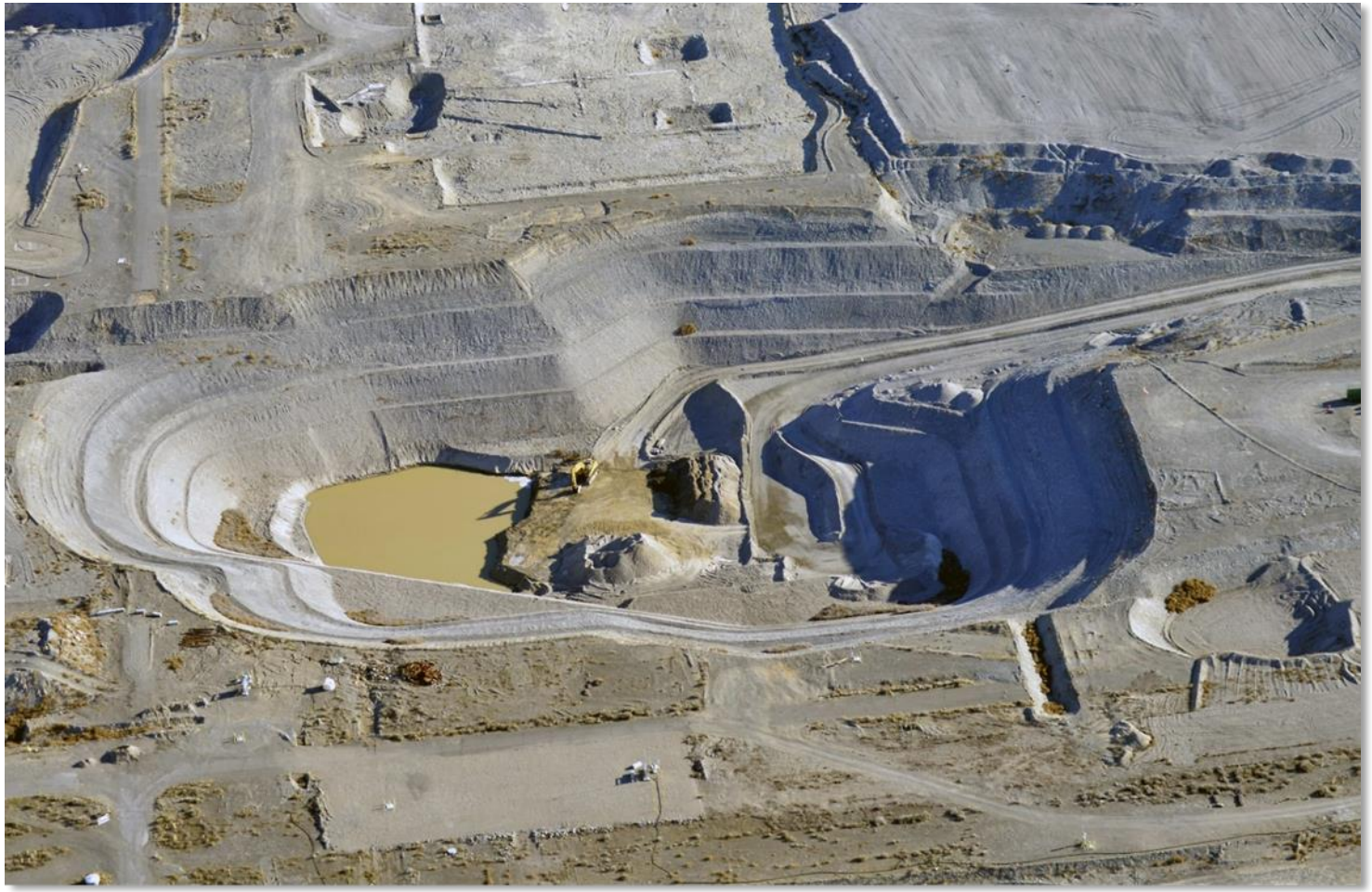
Columbia River Corridor Cleanup

- Groundwater is a pathway for contaminants to enter the Columbia River
- The predominant contaminants in Columbia River corridor groundwater include hexavalent chromium, nitrates, and strontium-90
- On the river corridor, DOE remediates groundwater through the following methods:
  - Five pump-and-treat systems located along the Columbia River
  - A permeable reactive barrier for strontium-90 in the 100-N Area.
  - Enhanced attenuation of uranium in the 300 Area, and monitored natural attenuation in the 100-F Area.

Waste Site – Excavation

100-D-100 excavation

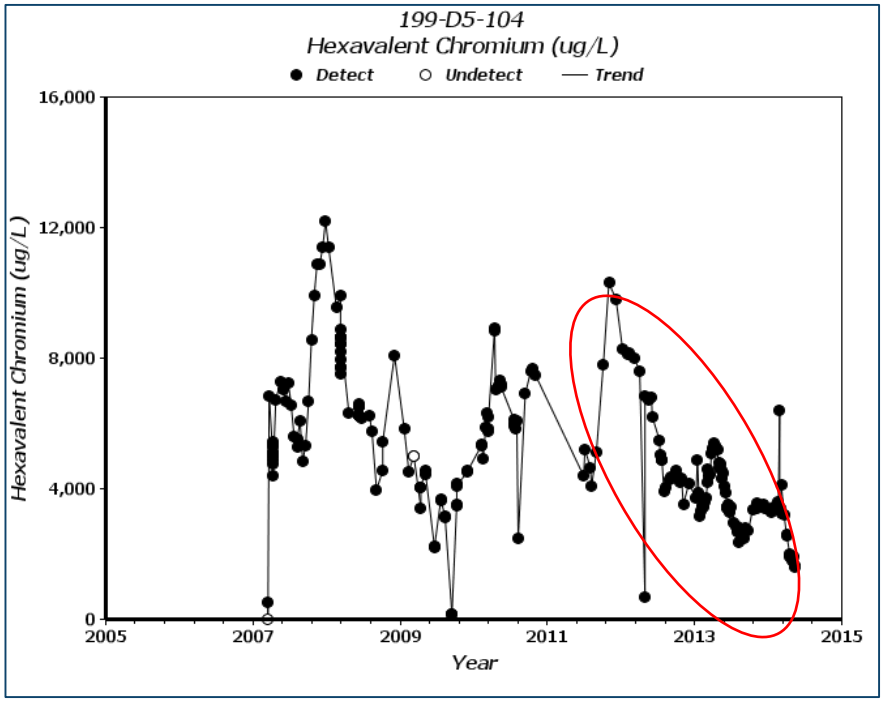
Waste Site – Excavation (cont.)



100-D-100 excavation

Hexavalent Chromium

Groundwater Cr(VI) at 40,000 ppb above, max at 70,000 ppb during transition from high to low river stage August 2010. Well decommissioned.



Declining Trend - on June 24, 2014, P&T (25 gpm) Cr(VI) concentration at 1424 ppb. MCL at 48 ppb.

River Corridor Pump-and-Treat Facilities

100-KX Process Facility

- Originally designed to treat 600 gpm
- System consists of 22 extraction wells and 10 injection wells
- Began pumping in 2009

River Corridor Pump-and-Treat Facilities (cont.)

100-KR Process Facility

- Originally designed to treat 300 gpm
- System consists of 11 extraction wells and five injection wells
- Began pumping in 1997

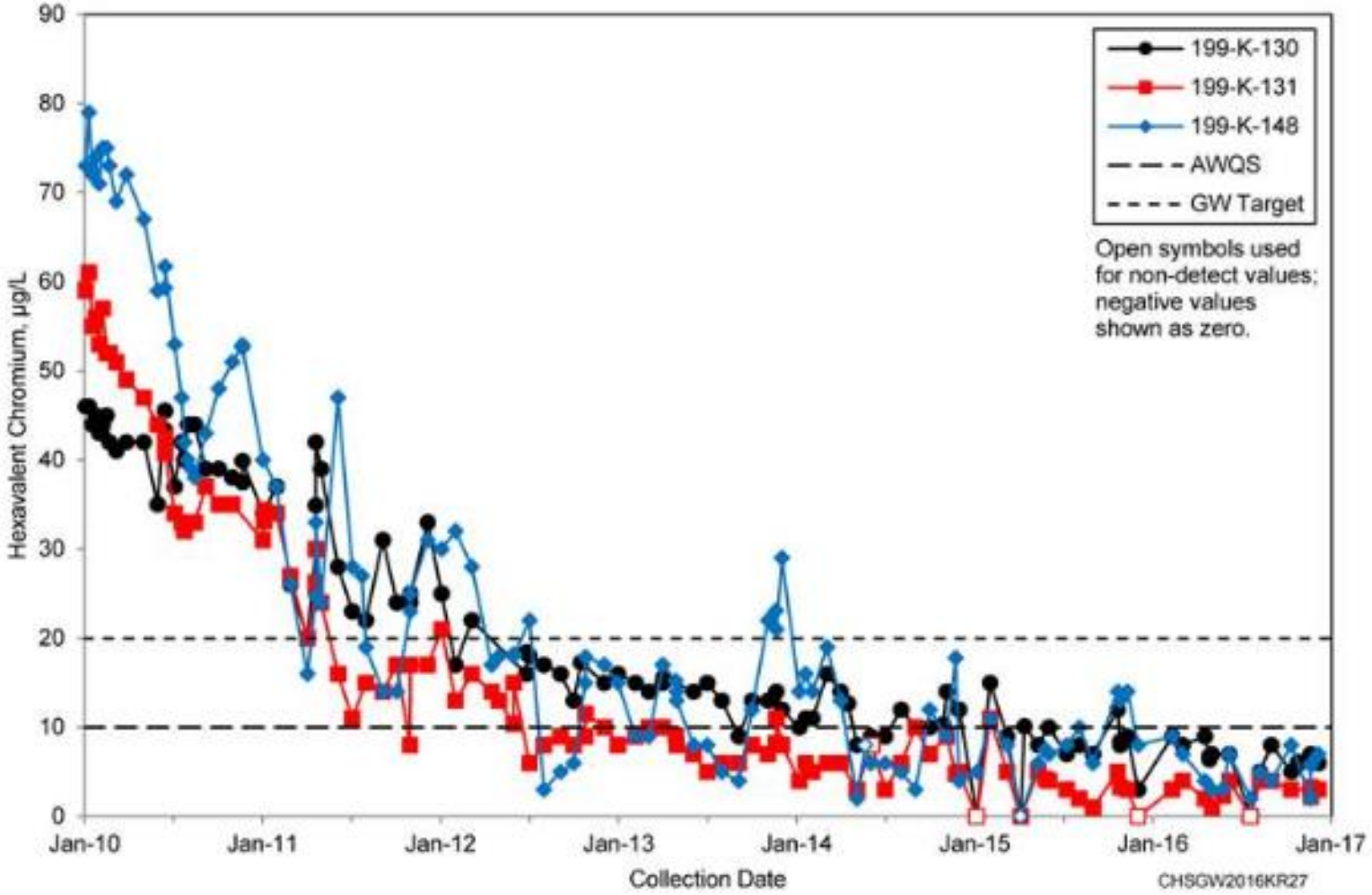
100-KW Process Facility

- Originally designed to treat 200 gpm
- System consists of five extraction wells and 4 injection wells
- Began pumping in 2007

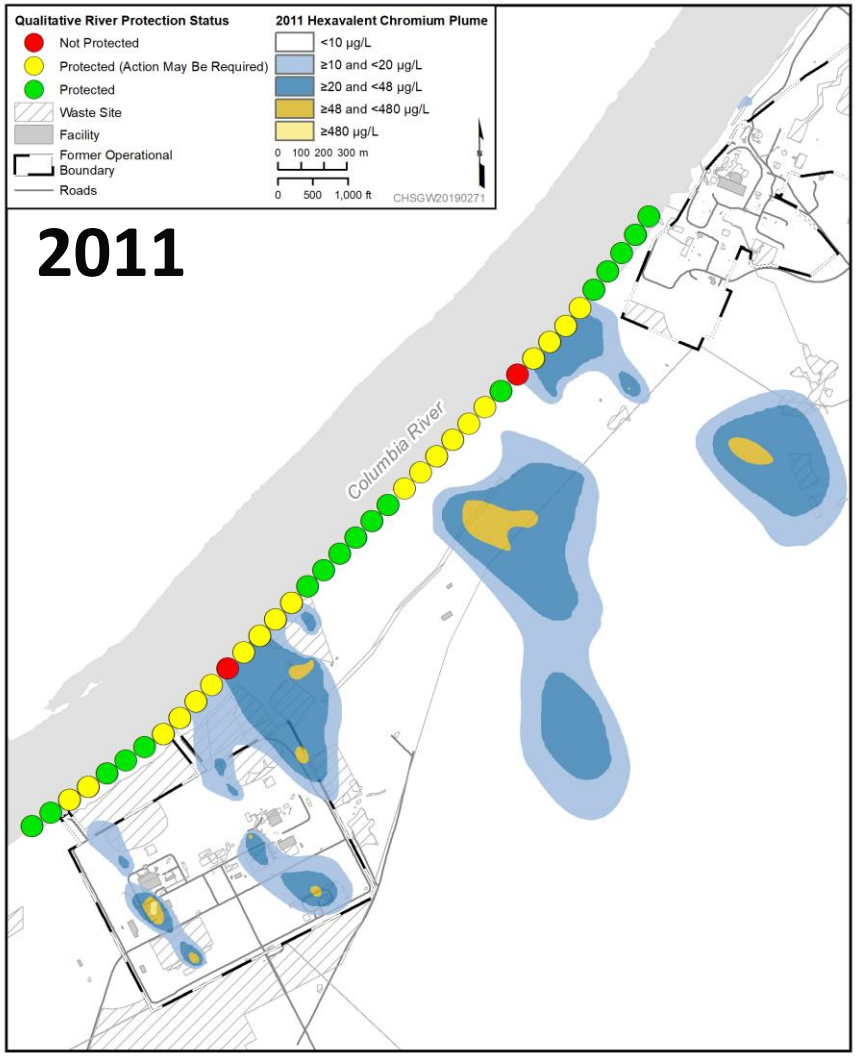
River Corridor Pump-and-Treat Facilities (cont.)

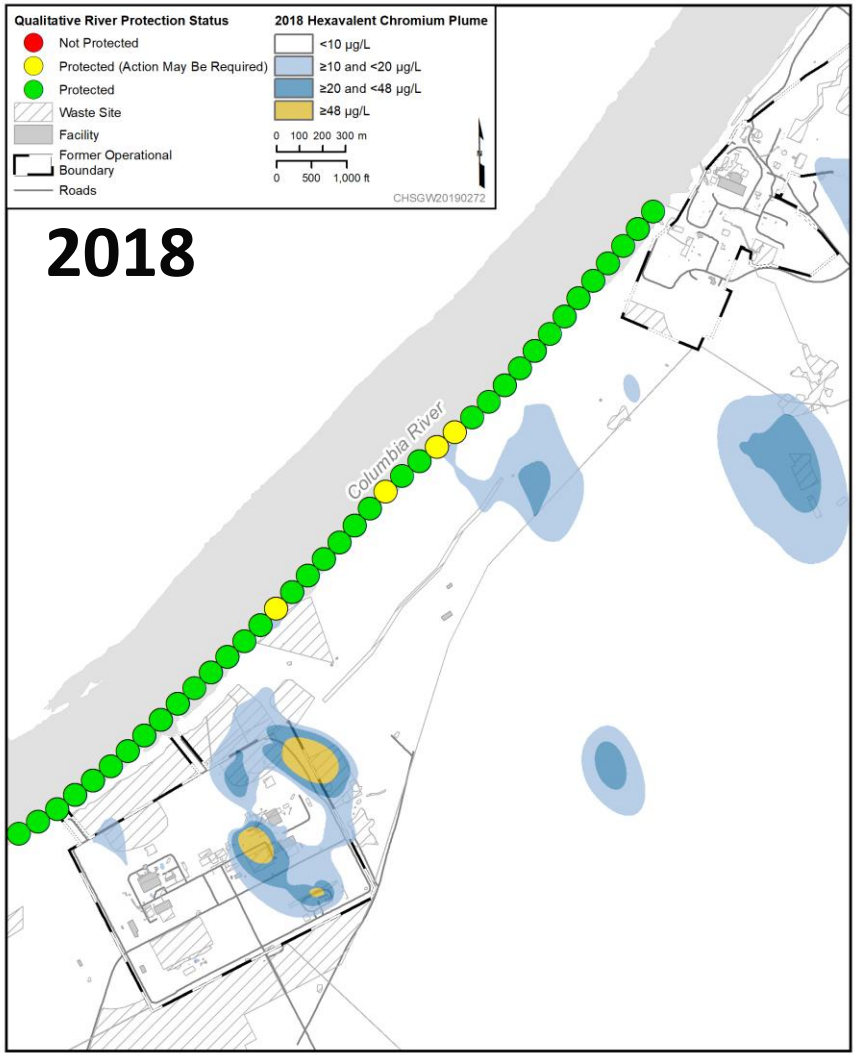
- KR-4, KW, and KX
- Total system design capacity: 1,560 gallons per minute, with new SIR-700 resin and configuration
- Operating wells: 39 extraction and 18 injection wells
- Between 2011 and 2018, processed a combined 4.8 billion gallons of water and removed approximately 360 kilograms of hexavalent chromium

River Corridor Hexavalent Chromium Data

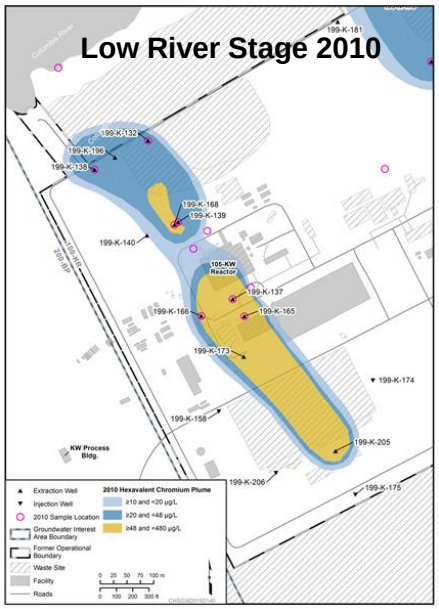


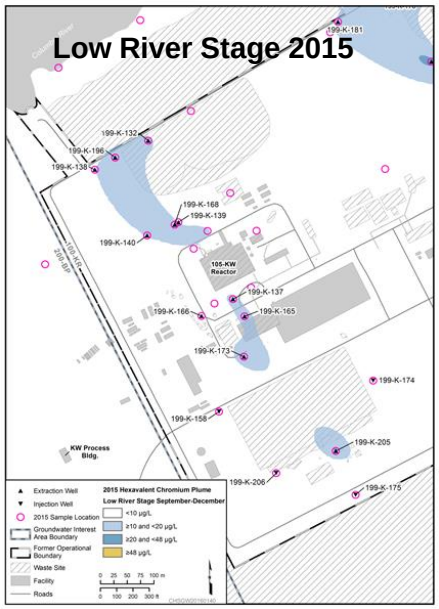
Hexavalent Chromium Plume at K Reactor Area

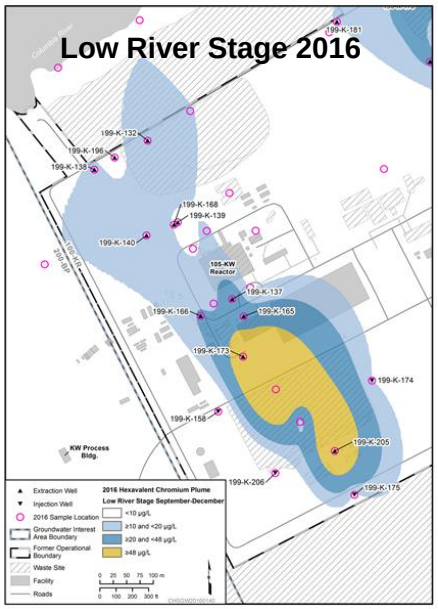


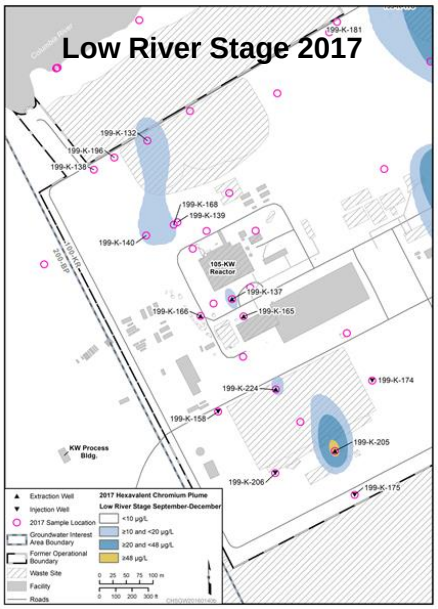


100 KW Reactor Area Soil Flushing Test



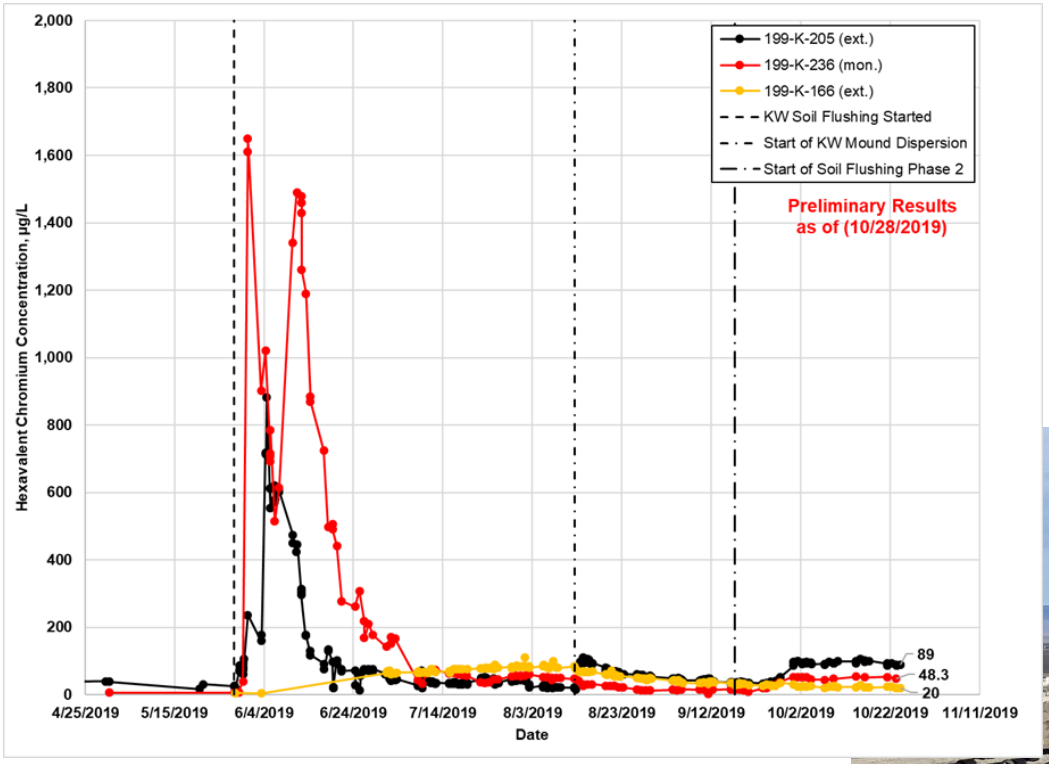






- KW hexavalent chromium plume has been under active remediation since January 2007
- By January 2016, all monitoring wells were below the groundwater remediation target of 20 µg/L
- A rebound study was performed between May 2016 and March 2017. Sampling and analysis indicated that a continuing hexavalent chromium source exists near the KW pump house.

100 KW Reactor Area Soil Flushing Test (cont.)



The test is being performed in phases to allow for saturation and drainage of the vadose zone.

After one pore volume (approximately 8.5 million gallons), the flushing was stopped and the water allowed to drain. Once drained, flushing was initiated again.

River Corridor Pump-and-Treat Facilities

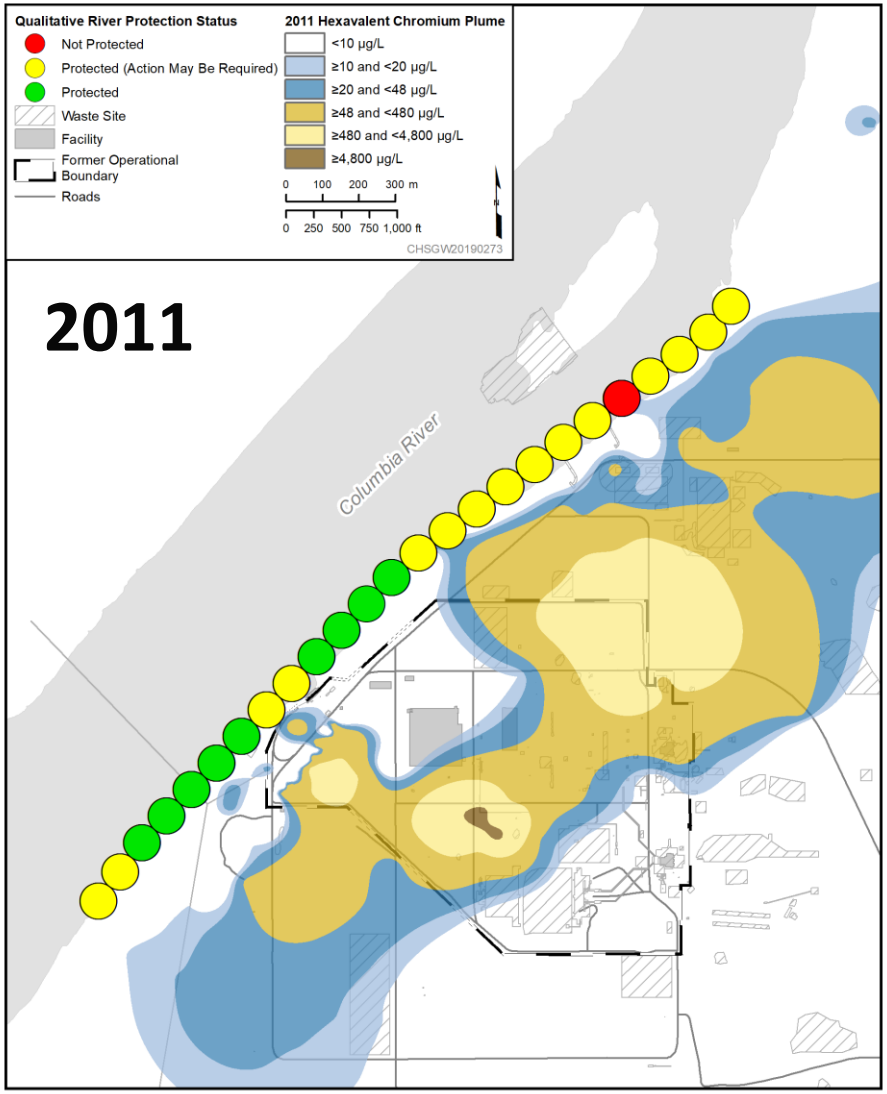
100-HX Process Facility

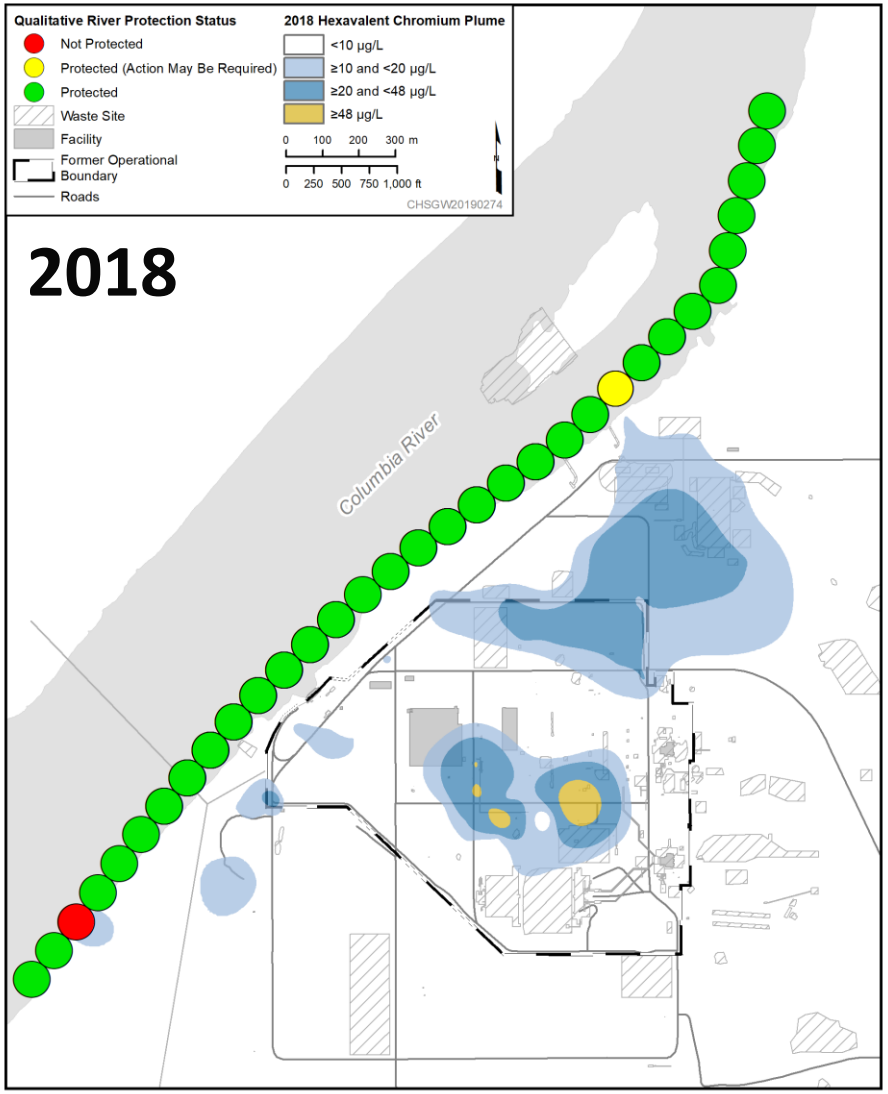
- Designed to pump 800 gpm
- System consists of 34 extraction wells and 16 injection wells
- Began pumping in 2011

100-DX Process Facility

- Designed to pump 600 gpm
- System consists of 46 extraction wells and 11 injection wells
- Began pumping in 2010

Hexavalent Chromium Plume D&H Reactor Areas





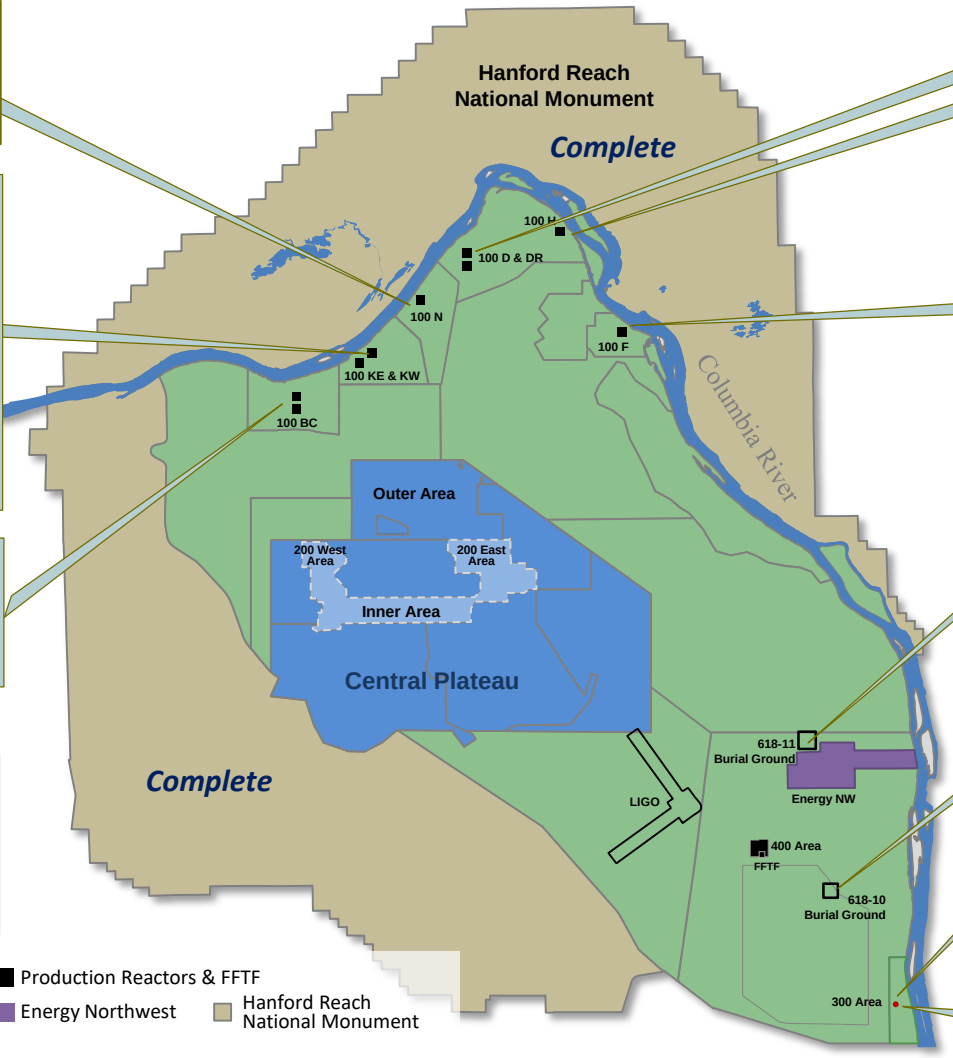
Remaining River Corridor Work

100-N Area (ROD in 2021/2022)
- Extension/re-injection at permeable reactive barrier
- RTD up to nine waste sites

100 K-Area (ROD in 2021/2022)
- Transport sludge to Central Plateau for treatment
- Demolish 34 facilities
- Remediate up to 43 waste sites (including pipelines)
- Put reactors in Interim Safe Storage
- Continued groundwater pump-and-treat processes for Cr(VI) (3 systems)

100-B/C Area (ROD in 2021)
- Continue groundwater MNA
- RTD one shallow waste site
- Institutional controls (IC)

Orchard Lands
- Field characterization complete
- Finalizing RI Report
- Developing FS Report
- Need for ROD undetermined



100-D/H Area (ROD in place)
- Shallow RTD 2 sites
- Confirmation sampling 2 sites
- 1 Barrier site
- Continued groundwater pump-and-treat processes for Cr(VI) (2 systems)
- MNA and ICs

100-F Area (ROD in place)
- Continued MNA
- Potential need for additional monitoring wells

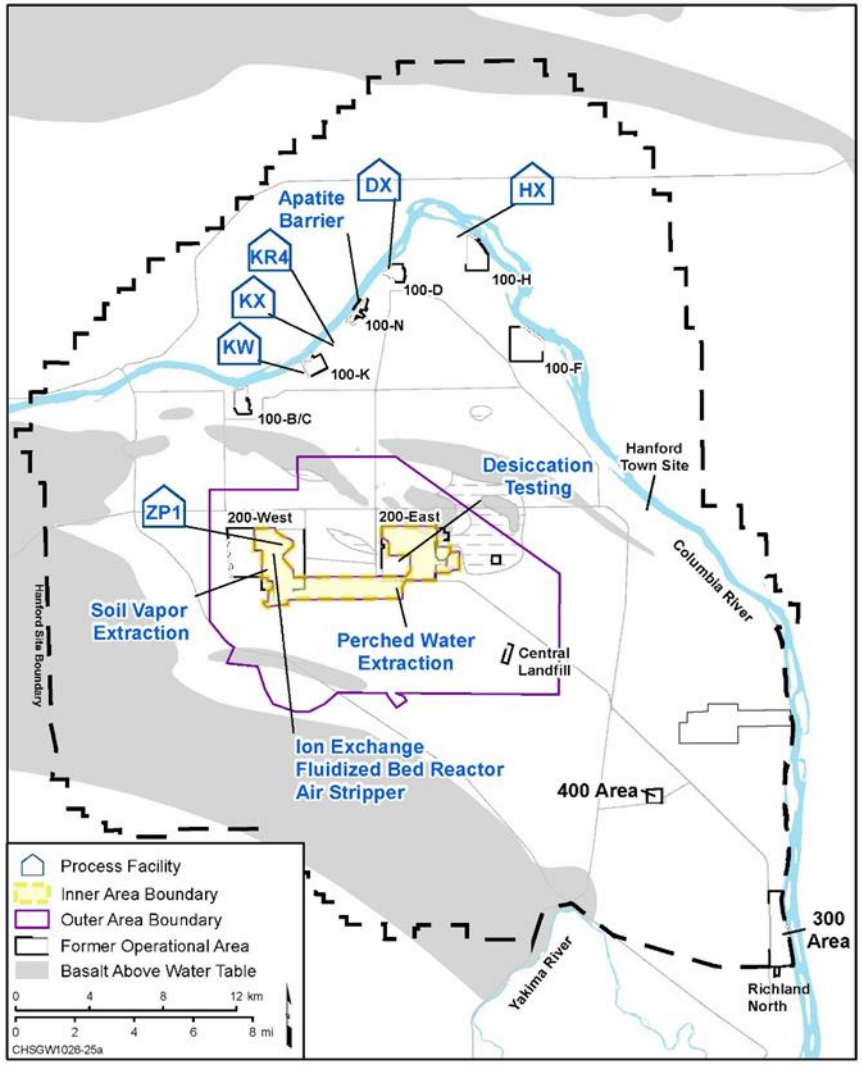
618-11 Burial Ground
Delayed RTD implementation (adjacent to operating nuclear station)

618-10 Burial Ground Remediation
Completed August 2018

300 Area (ROD in place)
- Completed uranium sequestration for groundwater
- Continued MNA
- Misc. waste site remediation

324 Building and Waste Sites
Continue waste retrieval

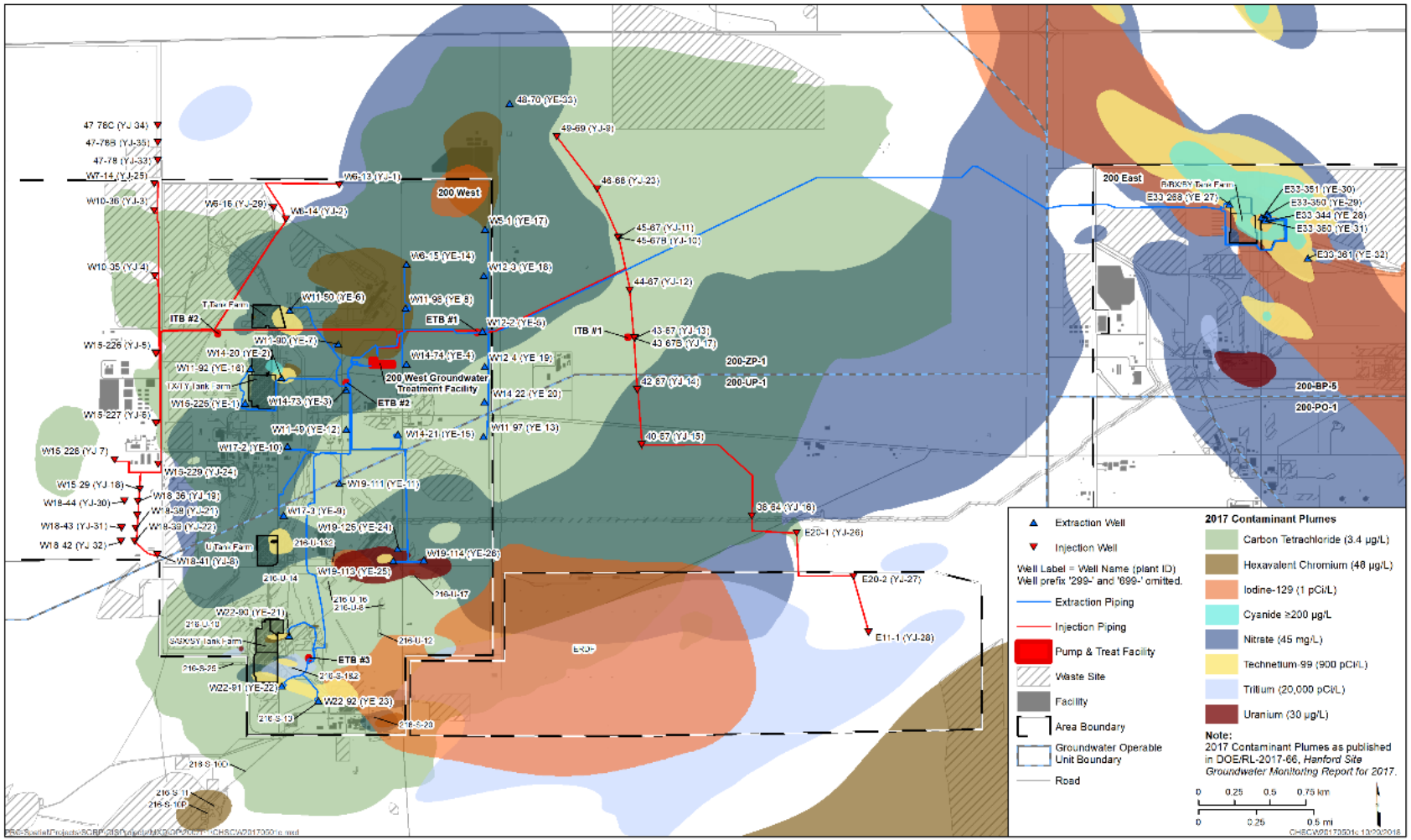
Central Plateau



Central Plateau (cont.)

- Central Plateau groundwater contaminants include tritium, iodine-129, nitrate, technetium-99, uranium, hexavalent chromium, cyanide, strontium-90, and carbon tetrachloride
- Five-year optimization study for suspension of nitrate treatment started in October 2019
- At the Central Plateau, DOE started the remediation of groundwater in 2012 using the 200 West Pump and Treat Facility
- Groundwater is treated until contaminants are below drinking water standards or can be shown to attenuate during the remediation period

Central Plateau Well Network



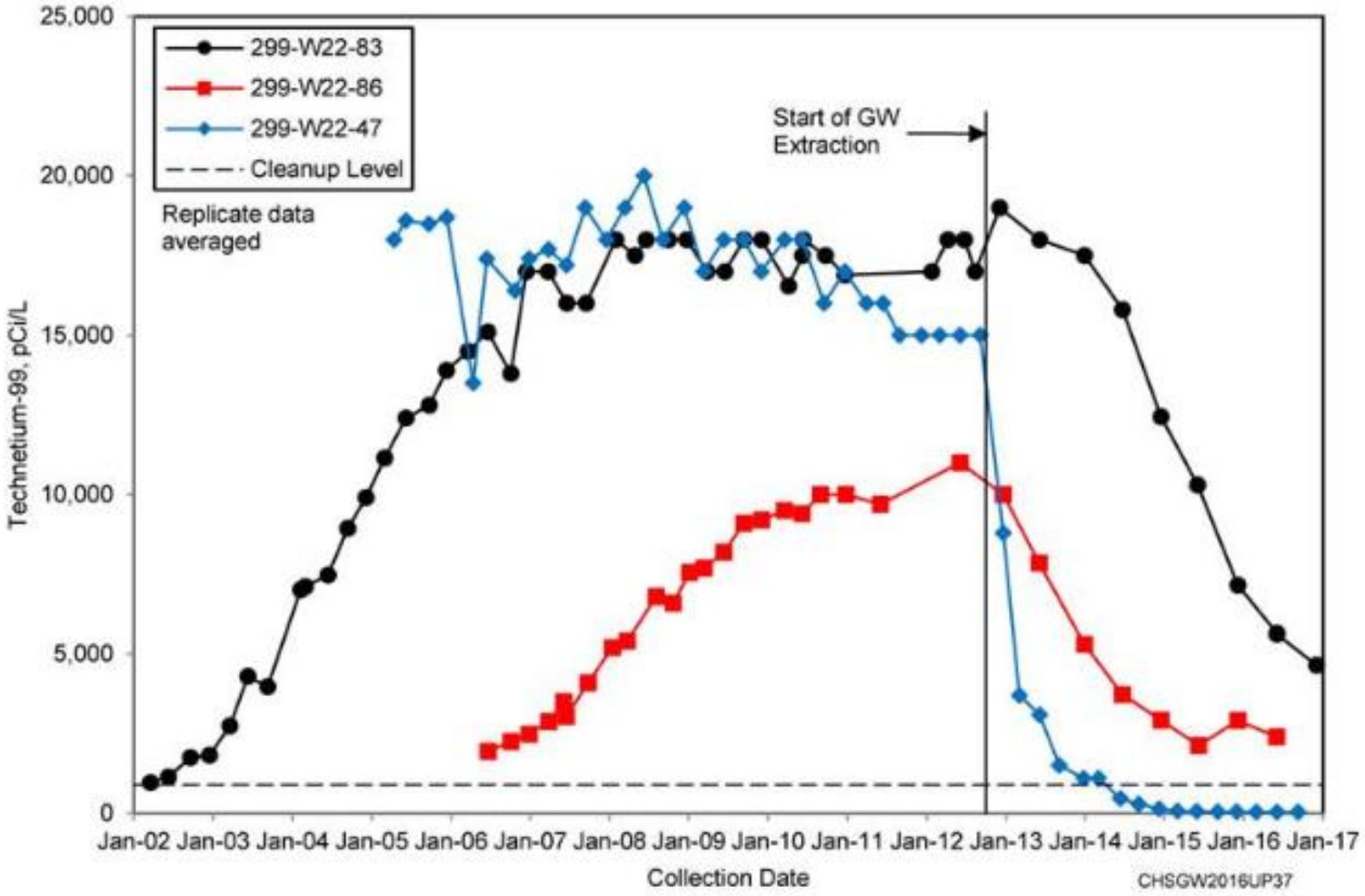
Central Plateau Pump-and-Treat Facility

200 West Pump and Treat Facility

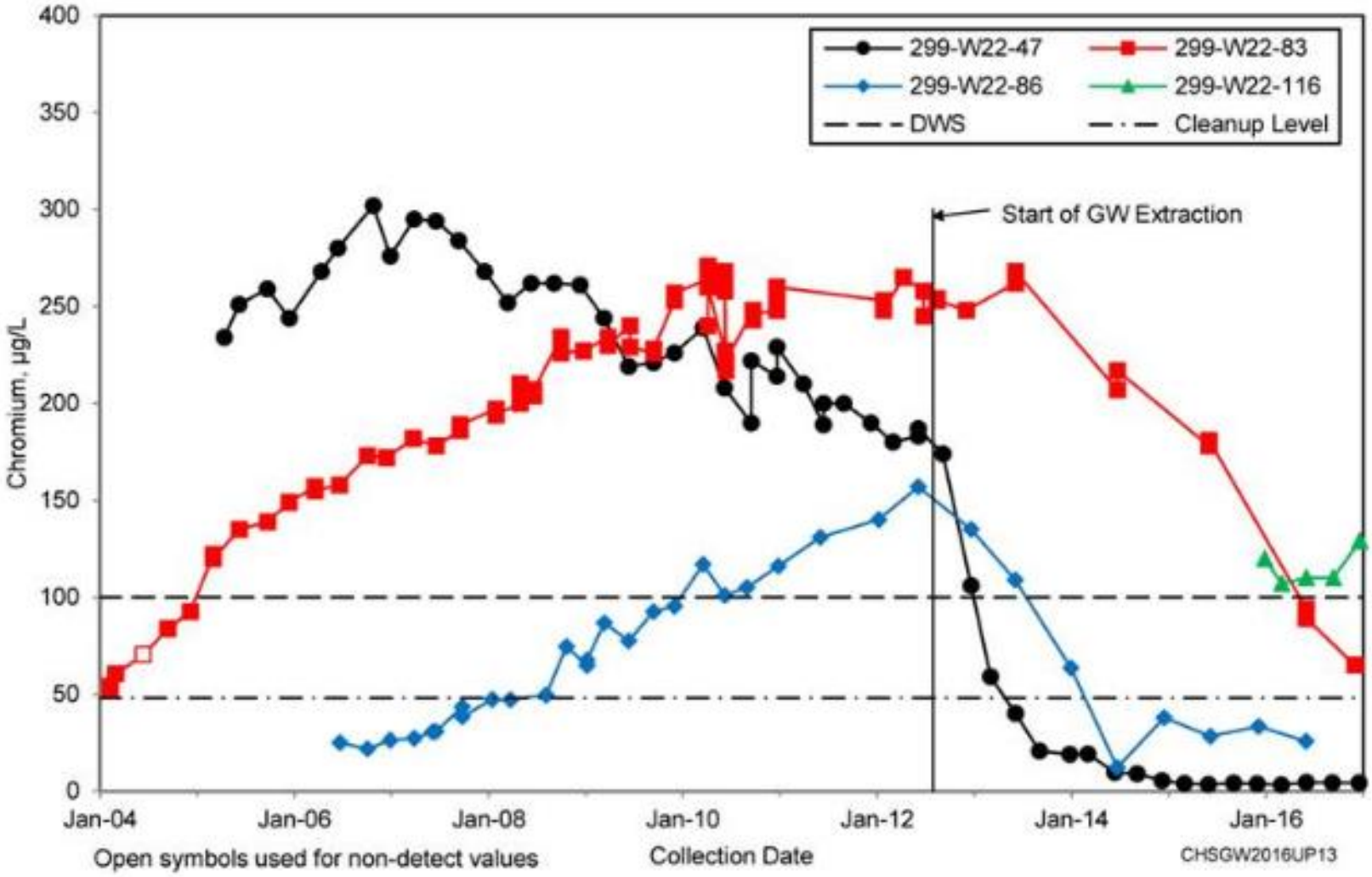
- Designed to treat 2,500 gpm
- System consists of 30 extraction wells and 27 injection wells
- Began pumping in 2012

Central Plateau Pump-and-Treat Facility (cont.)

Central Plateau Technetium-99



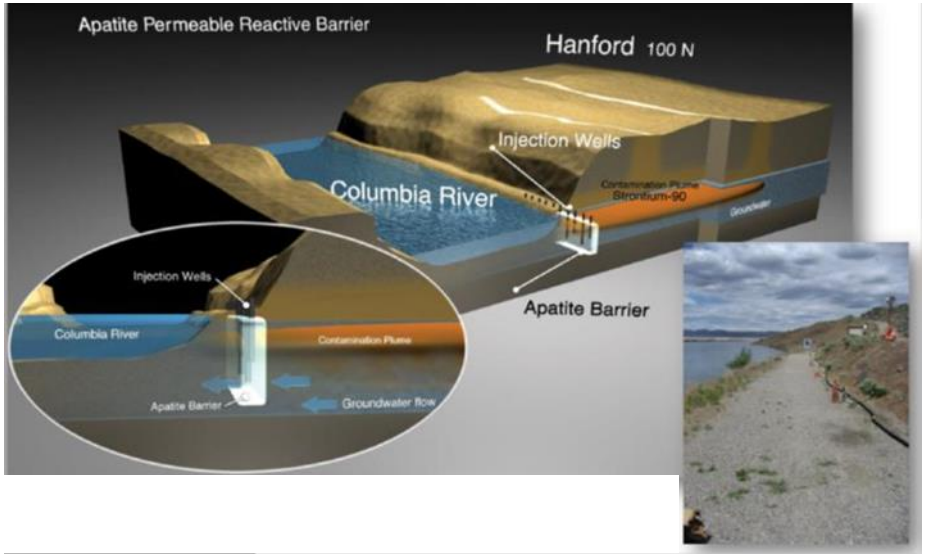
Central Plateau Chromium



Permeable Reactive Barrier

Process used to form the barrier:

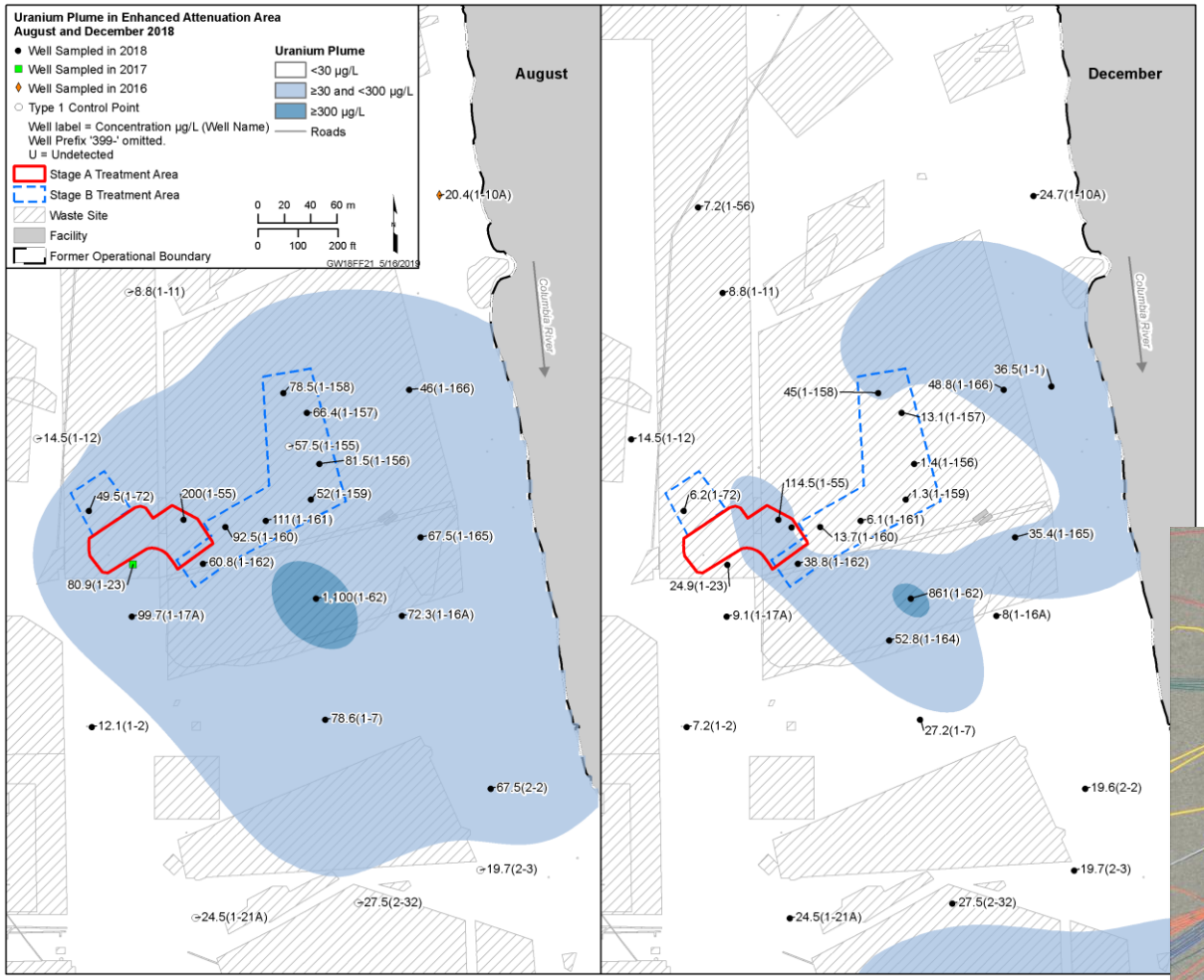
- Injection of calcium-citrate-phosphate solution to form a mineral barrier called apatite
- Strontium-90 bonds with apatite, making apatite more stable
- 162 injection wells to provide 762-meter-long barrier along the shoreline
- 29 monitoring wells for monitoring barrier performance



300 Area Uranium Sequestration

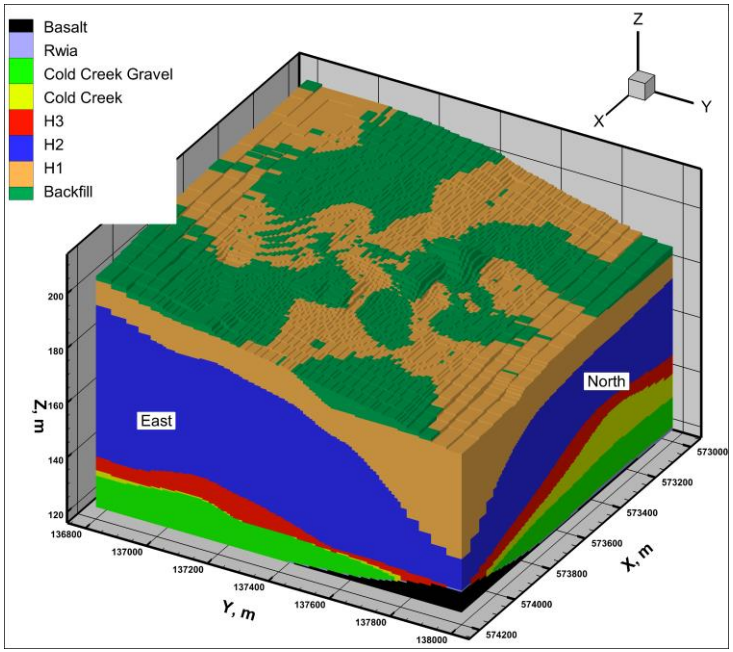
Infiltration and injection of phosphate solutions into the vadose zone, periodic wetted zone, and groundwater, will form insoluble minerals that bind mobile uranium.

300 Area Uranium Sequestration (cont.)



- Record of decision signed in November 2013
- Phase B injections completed October 2018
- Core samples obtained in spring 2019
- Report issued September 2020

Cumulative Impacts Evaluation



- Independent peer review
- Technical approach document issued September 2020
- All computer hardware installed

Cumulative Impact Evaluation (CIE) Calculations for No Further Action Scenario

- Vadose zone transport simulations are underway (24 models)
- Saturated zone transport simulations will be started soon for the 1000-year evaluation period
- Eight analytes are being simulated (Tc-99, I-129, H-3, Sr-90, uranium, chromium, cyanide, nitrates)

CIE Calculations for Most Anticipated Scenario

- Hanford Site Disposition Baseline has been developed
- Recharge estimation is underway for this scenario, using the Recharge Evolution Tool*
- Preparing inputs for the vadose zone transport models

CIE Other Activities

- Gathering data to address additional sources of anthropogenic recharge
- Maintaining Soil Inventory Model
- Assessing data gaps in vadose zone hydraulic properties

*The Recharge Evaluation Tool is the Hanford Sitewide Natural Recharge Boundary Condition for groundwater models.

Pump-and-Treat Facts

- The Central Plateau pump-and-treat facility is a major component of the remedial actions selected for cleanup on the Central Plateau
- The remedy selected in the record of decision Hanford 200 West Area includes a groundwater pump-and-treat system, monitored natural attenuation, flow-path control, and institutional controls
- The Central Plateau pump-and-treat facility is designed to capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, trivalent and hexavalent chromium, cyanide, nitrates, trichloroethene, iodine-129, technetium-99, and uranium
- Following treatment, the water is reinjected into the aquifer to serve as a recharge source and to promote flow-path control

Requirements

- DOE coordinates groundwater sampling for the CERCLA, *Resource Conservation and Recovery Act* and *Atomic Energy Act of 1954*
- CERCLA was enacted in 1980 and provides the legal authority to take action in response to releases that threaten human health and the environment
- The National Priority List is a list of the highest-priority sites where releases of hazardous substances have occurred in the United States
- Cultural and historic preservation is a significant component of remediation planning; DOE consults with area tribes through the Cultural Resource Program and Tribal Program.

CERCLA Process

There are five major phases in the remedial process:

- Remedial Investigation / Feasibility Study – The remedial investigation assesses the nature and extent of contamination and the associated health and environmental risks. The feasibility study develops and analyzes the range of potentially viable cleanup alternatives for the site.
- Selection of Remedy – Selects the remedial action alternative for the Site
- Remedial Design – Technical plans and specifications are prepared for implementing the remedial action alternative
- Remedial Action – Construction or other work necessary to implement the remedial action alternative
- Operation and Maintenance – Activities to ensure the cleanup methods are working properly and to ensure the Site remedy continues to be effective

Cleanup Goals: Waste Sites and Groundwater

Remediation began 20 years ago under the authority of interim cleanup decisions. The cleanup objectives included:

- Soil Contamination
  - Clean up soil contaminants to limit risk levels for people, and plants and animals that might be exposed
  - Clean up soil so contaminants do not reach groundwater above standards and risk levels
- Groundwater Contamination: Cleanup groundwater so contaminants are not above standards and risk levels for people, and groundwater will not be above standards and risk levels for plants and animals when it reaches surface water

Key Takeaways

- Process improvements have resulted in substantial progress in the removal of groundwater contaminants, shortening the period required to meet cleanup goals
- DOE and the contractor are always seeking more efficient and cost-effective ways to improve the performance of the groundwater treatment network, with protection of the Columbia River the ultimate goal

Questions